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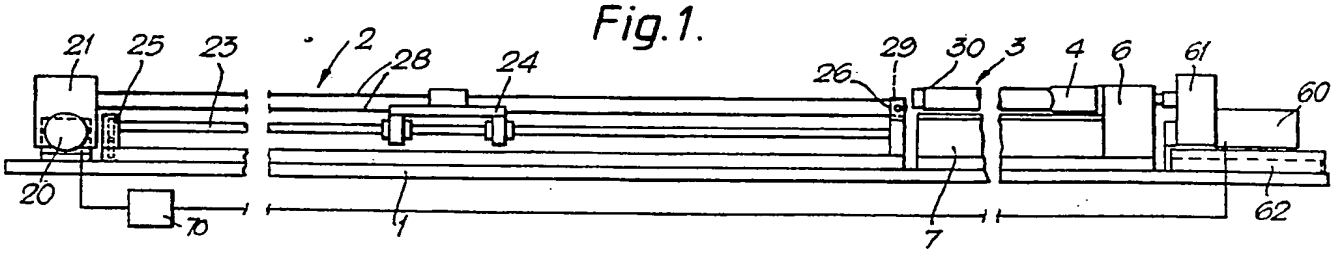
(54) Coating tube interiors

(57) A machine for coating the inside of a tube 4 has an extruder head 30 extending within the tube. A piston (50) Figure 6 is movable to force the coating material (64) into an annular recess (34) on one side of a spreader (35). The tube 4 is supported on two low friction rods (9) and (10) Figure (3) and is pulled along the extruder head 30 by a carriage 24 so that the spreader (35) wipes the coating material (64) along the inside of the tube.

Fig.1.



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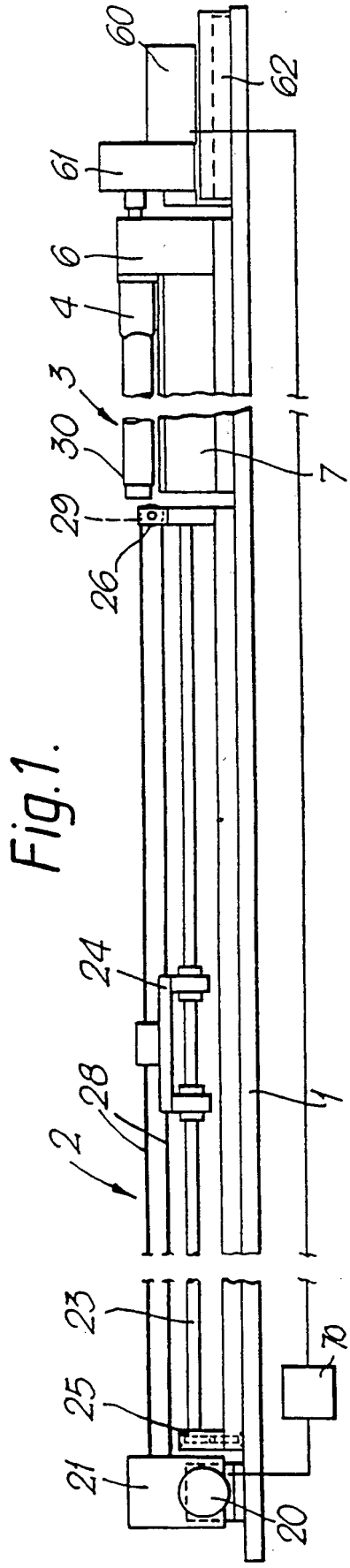

Fig.1.

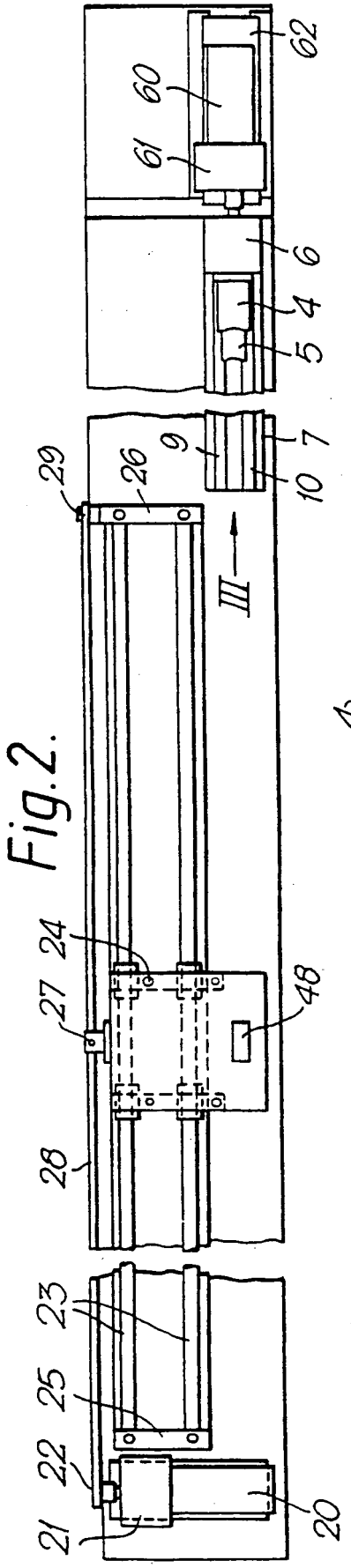

Fig.2.

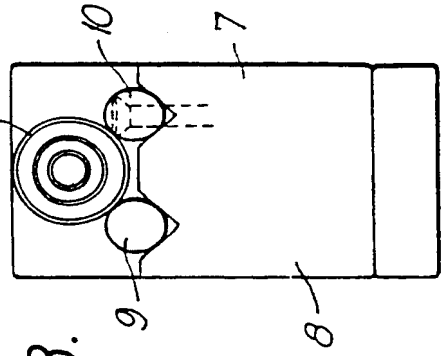

Fig.3.

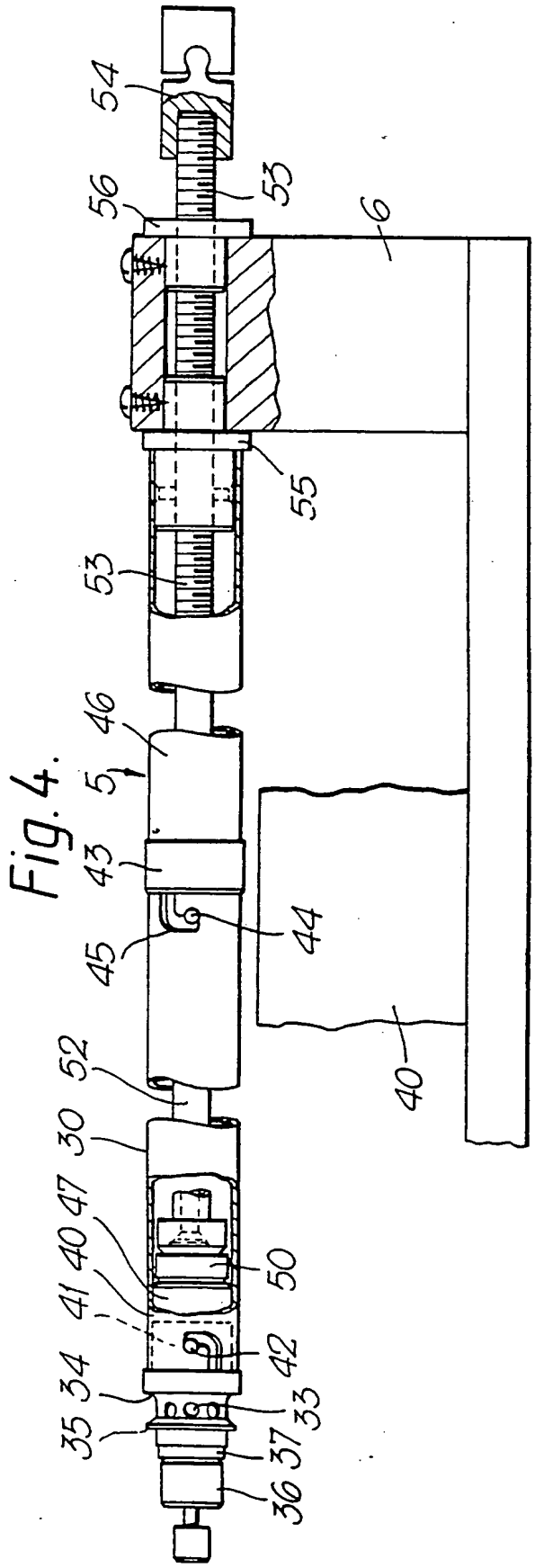
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Fig. 4.

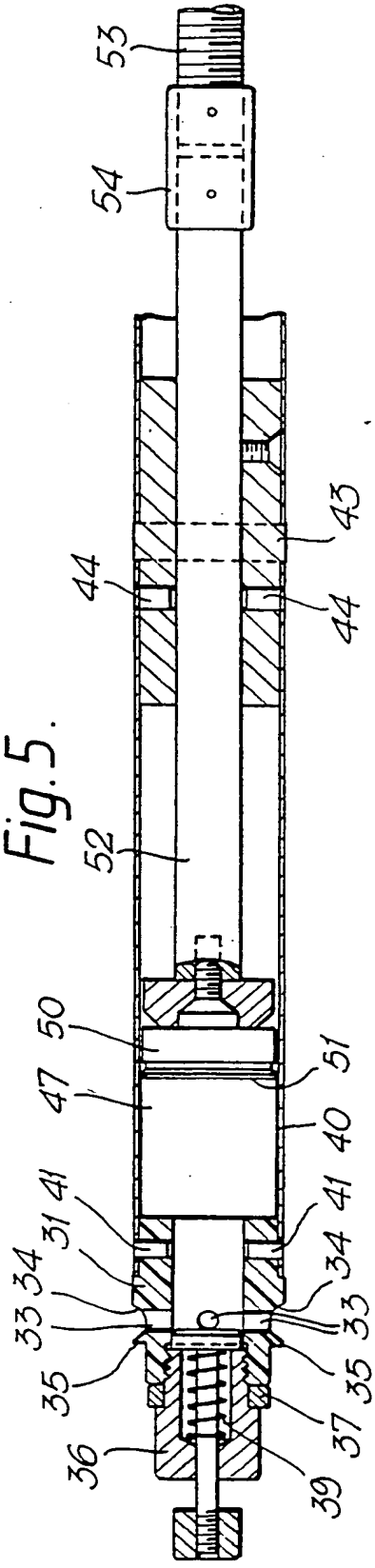
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Fig. 5.

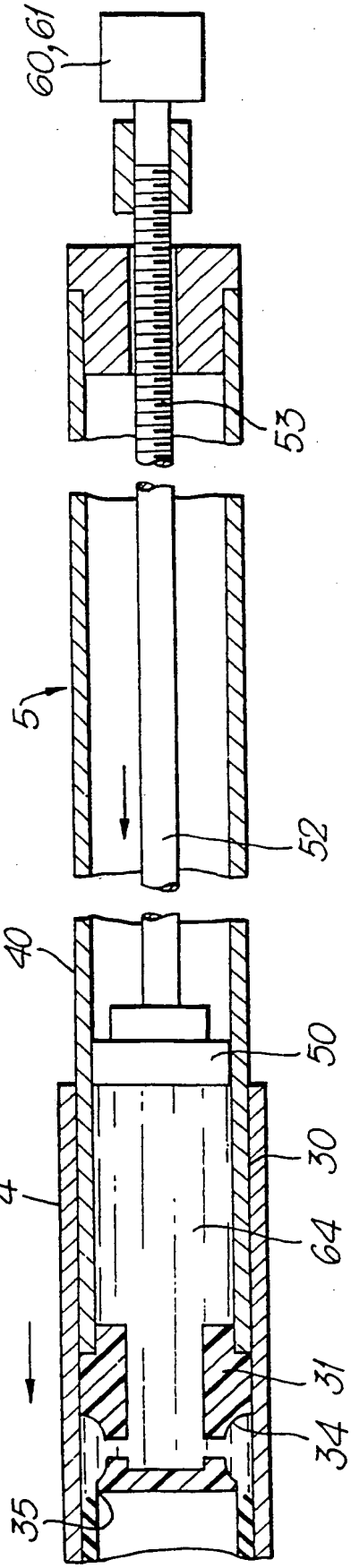

Fig. 6.

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COATING MACHINES AND METHODS

This invention relates to coating machines and methods and to coated tubes.

The invention is more particularly concerned with machines and methods of coating the inside of tubes.

Various methods are used currently to coat the inside of tubes. These include spraying, immersion, powder coating or pouring in a liquid. There can be problems with these methods in that it is difficult accurately to control the thickness of the coating, especially where the coating material is relatively viscous. One example of a tube that needs to be coated on its inside is a tube forming a part of an ultrasonic liquid level gauging probe of the kind described in GB 2265005.

It is an object of the present invention to provide an improved coating machine and method.

According to one aspect of the present invention there is provided a machine for coating the inside of a tube, the machine including an internal assembly arranged to extend internally of the tube, and means mounting the tube for displacement relative to the internal assembly along the length of the tube, and the internal assembly including an annular member with an external diameter less than the internal diameter of the tube, means defining an annular recess on a side of the annular member opposite from the direction of relative displacement, and means for supplying coating material in fluid form to the recess such that as the tube moves the coating material is spread along the inside of the tube by the annular member.

The means supplying coating material is preferably an extruder comprising a piston movable along the length of a cylinder. The machine may include a carriage movable along a rail, the carriage being attached to the tube so that the tube is displaced by movement of the carriage. The machine may include a motor and a drive belt loop coupled to the carriage such that rotation of the motor causes displacement of the drive belt and displacement of the carriage. The machine preferably includes a low friction support, such as two rods of a low friction material located on either side of the tube, extending beneath the internal assembly and arranged to support the tube so that the tube can slide along the support.

According to another aspect of the present invention there is provided a method of coating the inside of a tube including the steps of mounting the tube for displacement along its length relative to an internal assembly within the tube, supplying fluid coating material to an annular recess between the outside of the internal assembly and the inside of the tube and spreading the coating material over the inside of the tube with an annular member on the internal assembly as the tube is displaced relative to the internal assembly.

According to a further aspect of the invention there is provided a machine for performing a method according to the other aspect of the invention.

According to yet another aspect of the present invention there is provided a tube coated by a machine according to the above one or further aspect of the invention. The coating material may be a polysulphide rubber and the tube may form a part of an ultrasonic liquid level gauging probe.

A coating machine, method and a coated tube according to the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1	is a side elevation of the machine;
Figure 2	is a plan view of the machine from above;
Figure 3	is an end view of a part of the machine along the line III of Figure 2;
Figure 4	is a side elevation of a extruder mechanism in the machine;
Figure 5	is a sectional side elevation of the forward end of the extruder; and
Figure 6	is a simplified side elevation view of a part of the machine in operation coating a tube.

With reference first to Figures 1 to 3, the machine has a base board 1 about 500cm long and 15cm wide. The left-hand end of the board 1 supports a tractor mechanism 2 whereas the right-hand end supports an extruder mechanism 3. The extruder mechanism 3 has an extruder head 30 located within the tube 4 to be coated. The tube 4 is pulled to the left by the tractor mechanism 2 while the extruder head 30 coats the inside of the tube from its left-hand end to its right-hand end.

The tractor mechanism 2 has a motor 20 mounted laterally across the left-hand end of the board 1. The motor 20 is coupled via a gear box 21 to a toothed drive wheel 22. A double slide rail assembly 23, about 117cm long, extends along the upper side of the board 1 to the right of the motor 20 as viewed in Figure 2. A carriage 24 is slidable along the rail assembly 23 between stops 25 and 26 at opposite ends of the rail assembly. The carriage 24 has a peg 27 projecting from one side to which is attached a drive belt loop 28. At one end, the drive belt 28 extends around the drive wheel 22; at its opposite end, the belt extends around an idler wheel 29 attached to the right-hand stop 26 on the rail assembly. It can be seen that the carriage 24 can be displaced along the rail assembly 23 in either direction by rotation of the motor 20.

With reference now to Figures 4 and 5, the extruder mechanism 3 is mounted at the right-hand end of the board 1, to one side (Figure 2). The extruder head 30 is supported at the left-hand end of an elongate assembly 5 that is about 250cm long. The extruder mechanism 3 is supported towards its right-hand end by a pillar 6 and extends horizontally with its axis extending just above and to one side of the carriage 24. Beneath the extruder mechanism 3 extends a slide support 7. The slide support 7 comprises a rectangular block 8 with two rods 9 and 10 of PTFE, or a similar low friction material, which are about 13mm in diameter and about 137cm long (Figure 3). The rods 9 and 10 extend parallel to one another side-by-side, being spaced from one another by the diameter of the rods. The rods 9 and 10 provide a

support on either side of the tube along which it can be slid, there being a gap between both rods and the elongate assembly 5 sufficient to receive the wall of the tube as a free fit.

The extruder head 30 has a hollow nylon bush 31 with a central bore 32 opening through four radial holes 33 into an annular recess 34 around the outside of the bush. The left-hand side of the recess 34 is defined by a radially-projecting annular spreader member 35, which is inclined on the side facing the recess. The external diameter of the spreader 35 is 23.2mm, that is, slightly less than the internal diameter of the tube 4. The left-hand end of the bore 32 is threaded and receives a brass collet 36 screwed into the bush 31 and sealed with it by means of a PTFE sealing ring 37. The collet 36 supports a plug 38 and a helical spring 39, which urges the plug to the right, to a position in which it covers and blocks the holes 33. The right-hand end of the bush 31 is retained in the left-hand end of an aluminium alloy cylinder 40 by means of two pins 41 projecting from the bush and engaging in bayonet slots 42 in the cylinder. The cylinder 40 is 25cm long with an external diameter of 22.2mm and an internal diameter of 20.8mm. The right-hand end of the cylinder 40 is joined to a PTFE coupling 43 by means of pins 44 projecting from the coupling and engaging in bayonet slots 45 in the cylinder, the slots being cut in the opposite sense from those 42 at the left-hand end of the cylinder. The coupling 43 is fixed at the left-hand end of a second aluminium alloy cylinder 46 having the same diameter as the first cylinder 40 and being 200cm long. The right-hand end of the cylinder 46 is supported by the pillar 6.

The left-hand cylinder 40 provides a pump chamber 47 for the extruder head 3 and contains a piston 50 of PTFE with a wiping edge 51 at its left-hand end. The piston 50 is secured to the end of a metal rod 52 extending to the right through the coupling 43 and about 26cm long. As its right-hand end, the rod 52 is joined to a threaded metal rod 53 by means of a loose coupling 54, which allows for some variation in axial alignment between the two rods.

The threaded rod 53 extends through two internally-threaded brass bushes 55 and 56 secured to the pillar 6 so that rotation of the rod causes it to be displaced along its length. At its right-hand end, the threaded rod 53 is coupled to a motor 60 via a gearbox 61. The motor 60 and gearbox 61 are mounted on a slide 62 so that they can be displaced longitudinally of the machine through a limited distance.

Operation of the machine is controlled by a control unit 70 connected to both the extruder motor 60 and the traction motor 20.

Before operation, the piston 50 is displaced to the right by appropriately driving the motor 60, so as to enlarge the chamber 47. This also causes the motor 60 to be displaced to the right. The left-hand cylinder 40 is then uncoupled at its right-hand end from the bayonet coupling 43 so that this part of the extruder head 30 can be removed and filled with the coating material 64 (Figure 6). In the present example, the material is a polysulphide rubber fluid although any viscous or pasty fluid which cures or sets could be used. During this filling step, the plug 38 is displaced by the spring 39 to the right so that the holes 33 are blocked and escape of fluid is prevented.

The cylinder 40 is then replaced on the coupling 43 so that the left-hand face of the piston 50 contacts the polysulphide material. The tube 4 to be coated is then slid from left to right over the extruder head 30 so that it is supported from beneath on the rods 9 and 10 and is a close sliding fit on the extruder head. In the present example, the tube 4 is of aluminium alloy and has a length of 2m with an external diameter of 25.4mm. The carriage 24 on the tractor mechanism 2 is moved to the right-hand extent of its movement and the tube 4 is secured to the carriage by a clamp 48. The left-hand end of the tube 4 is positioned so that the

spreader 35 on the extruder head 30 is just within the tube. The control unit 70 then energizes both motors 20 and 60 at the same time. In this way, the tube 4 is pulled slowly to the left by the tractor mechanism 2 and the piston 50 is pushed to the left by the rods 52 and 53. As the piston 50 moves, it applies pressure to the coating fluid 64, forcing the plug 38 to the left and opening the holes 33. The coating fluid 64 flows out of the holes 33 into the annular recess 34. The fluid 64 contacts the inside surface of the tube 4 and is spread over it by the spreader 35 as illustrated in Figure 6. The thickness of the coating produced is determined by three factors: the difference between the internal diameter of the tube 4 and the external diameter of the spreader 35; the rate of extrusion; and the speed of movement of the tube. The rate of extrusion is controlled by the speed of the piston 50 and hence by the speed of the motor 60. The speed of the tube 4 is controlled by the speed of the traction motor 20. It is not essential for the spreader 35 to have a diameter that is smaller, in its natural state, than the inside of the tube. Instead, if the spreader were relatively flexible, it could be deformed to a smaller diameter when flexed by pressure of coating material emerging from the recess. The only requirement is that it has a smaller diameter than the interior of the tube during the extrusion process so as to allow the coating material to be applied to the tube.

When the tube 4 has been coated along its entire length, it is unclamped from the carriage 24 and removed from the machine. The internal coating is allowed to cure by exposure to air at room temperature. If the machine were used with different coating materials, different curing techniques could be used such as involving heating or exposure to curing compounds in gaseous or liquid form.

The present invention enables a coating of well-defined thickness to be produced readily in tubes and with relatively viscous fluids. The tube need not have a circular section.

CLAIMS

1. A machine for coating the inside of a tube, wherein the machine includes an internal assembly arranged to extend internally of the tube, and means mounting the tube for displacement relative to the internal assembly along the length of the tube, and wherein the internal assembly includes an annular member with an external diameter less than the internal diameter of the tube, means defining an annular recess on a side of the annular member opposite from the direction of relative displacement, and means for supplying coating material in fluid form to the recess such that as the tube moves the coating material is spread along the inside of the tube by the annular member.

2. A machine according to Claim 1, wherein the means supplying coating material is an extruder comprising a piston movable along the length of a cylinder.

3. A machine according to Claim 1 or 2, wherein the machine includes a carriage movable along a rail, and wherein the carriage is attached to the tube so that the tube is displaced by movement of the carriage.

4. A machine according to Claim 3 including a motor and a drive belt loop coupled to the carriage such that rotation of the motor causes displacement of the drive belt and displacement of the carriage.

5. A machine according to any one of the preceding claims including a low friction support extending beneath the internal assembly and arranged to support the tube so that the tube can slide along the support.

6. A machine according to Claim 5, wherein the low friction support includes two rods of a low friction material located on either side of the tube.

7. A machine substantially as hereinbefore described with reference to the accompanying drawings.

8. A method of coating the inside of a tube including the steps of mounting the tube for displacement along its length relative to an internal assembly within the tube, supplying fluid coating material to an annular recess between the outside of the internal assembly and the inside of the tube and spreading the coating material over the inside of the tube with an annular member on the internal assembly as the tube is displaced relative to the internal assembly.

9. A method substantially as hereinbefore described with reference to the accompanying drawings.

10. A tube coated by a method according to Claim 8 or 9.

11. A machine for performing a method according to Claim 8 or 9.

12. A tube coated by a machine according to any one of the Claims 1 to 7 or 11.

13. A tube according to Claim 12, wherein the coating material is a polysulphide rubber.

14. A tube according to Claim 12 or 13, wherein the tube forms a part of an ultrasonic liquid level gauging probe.

15. Any novel feature or combination of features as hereinbefore described.

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Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report) - 11 -	Application number GB 9403795.9
Relevant Technical Fields (i) UK Cl (Ed.M) F2P (PR, PTBL) (ii) Int Cl (Ed.5) B05C 7/00; B05B 13/06	Search Examiner R F PHAROAH Date of completion of Search 27 APRIL 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1-14

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A:	Document indicating technological background and/or state of the art.	&:	Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
Y	GB 1494574	(G FISCHER) see page 3, lines 120-127	1, 8 at least
Y	GB 1180651	(A O SMITH) see page 1, lines 65-68	1, 8 at least
Y	GB 547821	(G ANGUS) whole document	1, 8 at least

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